Neighborhood safety and green space as predictors of obesity among preschool children from low-income families in New York City

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Abstract

Background—Neighborhood safety, green space, walkability, and sociodemographics may influence physical activity and childhood obesity.

Methods—Data on measured height and weight, demographic characteristics, and home ZIP code were collected from year 2004 enrollees in a means-tested preschool program in New York City. Each ZIP code was surrounded by a 400-meter buffer and characterized using data from the US census, local government departments, New York Times website, and Transportation Alternatives. Linear and Poisson models were constructed using cluster robust standard errors and adjusting for child's sex, race, ethnicity, age, and neighborhood characteristics.

Results—Analyses included 11,562 children ages 3–5 years living in 160 residential ZIP codes. A higher homicide rate (at the 75th vs 25th percentile) was associated with a 22% higher prevalence of obesity (95% CI for the prevalence ratio (PR): 1.05 to 1.41). A higher density of street trees (at the 75th vs 25th percentile) was associated with 12% lower prevalence of obesity (95% CI for the PR: 0.79 to 0.99). Other neighborhood characteristics did not have significant associations with childhood obesity.

Conclusions—Among preschool children from low-income families, neighborhood homicide rate was associated with more obesity and street tree density was associated with less obesity.

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Keywords

Child; Preschool; Obesity; Adiposity; Residence Characteristics; Environment; Safety; Urban Population; Poverty

Introduction

Neighborhood built and social environments may shape physical activity and obesity throughout the life course (Davison and Lawson, 2006; Lee and Moudon, 2004; Papas et al., 2007). Very young children may be more responsive to the home environment (Rundle et al., 2009a; Suglia et al., 2012), while adolescents are able to take advantage of neighborhood physical activity facilities (Evenson et al., 2007; Gordon-Larsen et al., 2006; Grow et al., 2008). A few studies have shown the relevance of the neighborhood built environment to physical activity and adiposity for preschool aged children (Kerr et al., 2006; Lovasi et al., 2011; McDonald, 2008; Spence et al., 2008) but evidence remains mixed (Burdette and Whitaker, 2004; Davison and Lawson, 2006).

Many built environment and health studies have focused on walkable urban form (Ewing and Cervero, 2010; Papas et al., 2007; Saelens and Handy, 2008), including features such as residential density, land use mix, and street design. However, these measures of walkability may not be salient for all population groups (Lovasi et al., 2009a; Lovasi et al., 2009b). Further, even neighborhoods with highly walkable urban form may have safety or aesthetic problems, particularly in economically deprived areas (Neckerman et al., 2009; Zhu and Lee, 2008).

Green spaces such as tree-lined streets and parks may encourage physical activity and a healthy weight (Boldemann et al., 2006; Larsen et al., 2009; Lovasi et al., 2012a; Lovasi et al., 2011). Yet accounting for other aspects of the environment, such as safety, may be crucial for understanding disparate quality of green space available to residents of low-income urban neighborhoods (Weiss et al., 2011).

Children in resource-limited urban settings may be particularly vulnerable to safety problems that could stop parents from allowing their children to play outdoors (Carver et al., 2010; Lovasi et al., 2011; Weir et al., 2006). Although perceived safety has been previously linked to childhood physical activity and obesity (Davison and Lawson, 2006; Lumeng et al., 2006), point-level objective (audit-based or GIS) measures of safety are not widely investigated and studies have not consistently accounted for other aspects of neighborhood context that may confound an association between safety and obesity.

To advance our understanding of how walkability, green space, and safety affect early life adiposity, we used data from a large population of preschool children from low-income families. Geographic data were linked to sociodemographic and anthropometric data. We hypothesized that children living in areas with more crime and traffic safety hazards (indicated by homicide rate and pedestrian-fatality rate) would have a higher BMI z-score and obesity prevalence, even after accounting for walkable urban form and green space (street trees and parks), which were hypothesized to predict lower BMI z-score and obesity prevalence.

Methods

Subjects and Setting

Data were from a cross-sectional census of 16,176 unique enrollment records for a large preschool program in New York City (NYC) as of October 2004 (Young et al., 2006). Eligibility to enroll in this preschool program was based on whether household income was below the federal poverty line. Analyses of these data were approved by the Columbia University Medical Center Institutional Review Board.

Individual Anthropometric and Sociodemographic Data

Measured height and weight were recorded by the child's health care provider, along with demographic data and physical exam date, on a form submitted at the time of initial enrollment in the preschool program. Height and weight were used to calculate a BMI z-score based on a comparison to Centers for Disease Control and Prevention (CDC) growth charts for children of the same age and sex (Ogden et al., 2002). BMI z-score was categorized into normal weight (<85th percentile), overweight (85th to 94th percentile), and obese (95th percentile). Missing values and implausibly extreme values were excluded in accordance with CDC recommendations.

Recorded date of birth was used to calculate age in months at the time of the physical exam. Children in the dataset with physical exams before the age of 3 years (N=3,293) or after the age of 5 years (N=95) were excluded, as were those with a physical exam date before 2003 (N=14) or after 2004 (N=3) to limit confounding by age or year. Sex (male or female) and race/ethnicity (Hispanic, Black/African American, White, Asian-American, or other/ American Indian/Alaskan Native) categories were recorded. The racial categories White and Asian-American were combined for analyses based on relatively small numbers and similar mean BMI z-score and obesity prevalence observed.

Geographic Measures

The enrollment file included the postal ZIP code for each child's home address; children with invalid or missing ZIP codes were excluded (N=51). The children lived in 160 unique NYC ZIP codes (90% of the 177 ZIP codes in NYC). To include resources and hazards relevant to physical activity that are potentially within a short walk from the ZIP code boundary, each home ZIP code was surrounded by a 400-meter buffer; 400-meters was selected to approximate a 5 minute walk, and the addition of this buffer increased the median neighborhood land area from 3.2 km^2 to 6.4 km^2. Water bodies were removed before calculating land area of postal and buffered ZIP codes. Buffered ZIP code neighborhoods were characterized through a spatial overlay with geographic data from multiple sources.

Sociodemographic characteristics (percent poverty, percent black race, and percent foreign-born) and population (count of residents) were measured through block group-level data from the year 2000 US Census, summary file 3. Block groups were intersected with buffered ZIP codes to create area-weighted averages.

Land use mix and residential density were constructed using the 2004–2005 Primary Land Use Tax Lot Output (PLUTO) data, a parcel-level dataset available from the NYC Department of City Planning. Intersection density was calculated using the street centerline GIS layer from the New York State Accident Location Information System (NYS-ALIS). Subway stops per square kilometer were from 2007 NYC Metropolitan Transit Authority data (2007 data were preferred over earlier versions because of improved spatial alignment and because stop locations are relatively stable over time). A walkability index was

constructed as previously described (Freeman et al., 2012; Neckerman et al., 2009) by summing z-scores for residential density (residential units per km^2), land use mix (an entropy-based measure constructed from residential, educational, entertainment, retail, and office land uses), retail floor area ratio (retail floor area per km^2), intersection density (unique street intersections per km^2, a measure of street connectivity), and subway stop density (subway stations per km^2).

The density of street trees (based on a 2005–2006 street tree census) and park area per km^2 were estimated as described previously (Lovasi et al., 2011; Lovasi et al., In Press; Weiss et al., 2011) based on data from the NYC Department of Parks & Recreation. Large parks were defined as 0.024 square kilometers (6 acres) or greater.

Safety hazard indicators included homicide rate and pedestrian-auto fatality rate. Homicide locations for years 2003 and 2004 were collected from the New York Times website (http://projects.nytimes.com/crime/homicides/map/) as described previously (Lovasi et al., 2012a; Lovasi et al., In Press; Weiss et al., 2011). Homicide rate was selected as the primary indicator of crime safety because of its spatial precision (in contrast to other crime data available at the precinct level), and because of expectations that homicide rate would be potentially salient in shaping safety perceptions and correlated with less severe criminal infractions. Locations of fatal pedestrian-auto collisions in 2003 and 2004 were based on the nearest intersection provided by Transportation Alternatives (http://crashstat.org/resources/). The pedestrian-auto fatality rate was used as the primary indicator of traffic hazards to limit potential bias from selective under-reporting of less serious injuries.

ArcGIS, version 10.0, was used for all geospatial analysis (ESRI, Redlands, CA).

Statistical Analysis

Primary analyses were continuous linear models predicting BMI z-score. Prevalence ratios were estimated via Poisson regression models (Lovasi et al., 2012c) predicting obesity (BMI z-score 95th percentile) versus normal weight or overweight. All models accounted for clustering within 160 ZIP codes using robust standard errors, and included adjustment for the child's sex, race/ethnicity, and age in months, as well as all neighborhood characteristics. Regression models were estimated using Stata 11.0 (Stata Corp., College Station, TX, USA).

Results

Of 16,176 records, 11,562 (71%) were ages 3–5 years at the time of their physical exam in 2003 or 2004, and were successfully matched to neighborhood characteristics based on buffered ZIP codes, and had valid BMI z-scores and complete covariate data (Table 1).

Neighborhood sociodemographic composition, built environment measures, and safety hazard indicators varied across ZIP codes (Table 2). These neighborhood characteristics, based on ZIP code plus a 400-meter buffer, have been rescaled for ease of comparison to have an interquartile range equal to 1. Thus, linear model coefficients can be interpreted as providing information on the expected difference in BMI z-score between the 75th and 25th percentiles for that neighborhood characteristic, and Poisson models can similarly be interpreted as providing the prevalence ratio comparing the 75th and 25th percentiles (Tables 3 and 4).

Neighborhood socioeconomic disadvantage, frequently measured using percent poverty, (Soobader and LeClere, 1999) is expected to predict higher BMI z-score and a higher risk of obesity in most US contexts (Spruijt-Metz, 2011). However, we observed the opposite in

this population of children from low-income families. A higher concentration of neighborhood poverty (75th versus 25th percentile) was associated with a 0.1 unit lower BMI z-score and a 13% lower prevalence of obesity after adjusting for individual and neighborhood characteristics (Tables 3 and 4). These inverse associations between neighborhood percent poverty and obesity were not statistically significant in models without mutual adjustment for other neighborhood characteristics (data not shown).

Neighborhood street tree density was associated with lower obesity prevalence (Table 4). A difference in street tree density from the 25th to the 75th percentile was associated with 12% lower prevalence of obesity. However, the available measures of walkable urban form and park access did not have significant associations in continuous or Poisson models.

Of the safety hazard indicators, homicide rate, but not pedestrian-auto fatality rate, was significantly associated with both higher BMI z-score and higher obesity prevalence (Tables 3 and 4): a difference in homicide rate from the 25th to the 75th percentile was associated with 0.13 units higher BMI z-score and a 22% higher prevalence of obesity.

Confidence intervals for the sex-stratified models overlapped; however, percent poverty and homicide rate were only statistically significant predictors of BMI and obesity among males (Tables 3 and 4). Sensitivity analyses examining the original ZIP codes (without a 400-m buffer) as the neighborhood definition yielded similar results (data not shown). Results were also similar in sensitivity analyses adjusting for quartiles of unhealthy food outlet density as defined previously (Rundle et al., 2009b) or when an outcome comparing obese or overweight (BMI z-score   85th percentile) versus normal weight were considered, and although the confidence intervals overlapped almost completely with our main results, the associations with street tree density were no longer statistically significant in these sensitivity analyses (data not shown).

Discussion

Among preschool children from low-income NYC families, neighborhood homicide rate was associated with a higher BMI z-score and a higher risk of obesity. Neighborhood poverty had an unexpected association with lower BMI z-score and lower obesity prevalence in fully adjusted models. Street tree density was associated with lower obesity prevalence. Walkability, park access, and pedestrian-auto fatalities were not significantly associated with adiposity in this study.

These findings add to a literature that highlights the importance of safety concerns shaping the physical activity patterns of children (Lovasi et al., 2011) and adults (Lovasi et al., 2012a; Lovasi et al., In Press) in high-poverty urban settings. In addition, crime rates may be important determinants of a child's sedentary behaviors (Brown et al., 2008; Burdette and Whitaker, 2005) which increase risk of childhood obesity (Spruijt-Metz, 2011).

The lack of association for neighborhood walkability may seem surprising given previously reported associations (Ewing and Cervero, 2010; Freeman et al., 2012; Papas et al., 2007). However, walkable urban form has shown weaker associations with physical activity and obesity among disadvantaged racial, ethnic, and socioeconomic population groups (Casagrande et al., In Press; Freeman et al., 2012; Lovasi et al., 2009a; Lovasi et al., 2009b). Since this population of children is exclusively from low-income families, the lack of association between walkability and BMI echoes findings from other low-income settings, perhaps owing to other barriers such as safety hazards or low perceived behavioral control (Alfonzo, 2005; Blacksher and Lovasi, 2012).

Green spaces were hypothesized to be associated with less adiposity. A previous study of preschool children from low-income NYC families found that street trees and parks were associated with more objectively measured physical activity (Lovasi et al., 2011). Importantly, previous findings in other settings have linked surrounding greenness to objectively measured childhood physical activity (Almanza et al., 2012) or longitudinal changes in childhood obesity (Bell et al., 2008). Yet there may be important distinctions among green spaces that make some more health supportive than others. In particular, the absence of association between park access and adiposity in the present study may be related to park disamenities, which are more prevalent in lower income neighborhoods (Weiss et al., 2011).

Our study was designed to juxtapose neighborhood characteristics in mutually-adjusted models. An important area of future work is to explore potential interactions among environment characteristics (Durand et al., 2012; Lovasi et al., 2012a) and between environment and population characteristics (Lovasi et al., 2012b; Lovasi et al., 2009a).

Strengths and Limitations

A key strength of this study was our inclusion of a large number of preschool age children from low-income urban settings based on an enrollment file which may be less vulnerable to selection bias than previous volunteer or convenience samples. Our findings were based on independent assessments of anthropometry and the neighborhood built environment. While this approach avoids bias due to correlated errors, it does not provide the opportunity to incorporate parental perceptions of the local environment. A strength of our approach was the addition of a 400-meter buffer around each ZIP code to address the potential accessibility of adjacent areas, a strategy that may be particularly important if resources or hazards are clustered along the ZIP code boundary. Precision and validity may be further improved by defining personalized neighborhood areas accounting for perceived neighborhood boundaries (Cosco et al., 2010) or travel patterns (Beyea and Hatch, 1999; Oliver et al., 2007).

The limited generalizability and potential for bias in this cross-sectional study should be considered. Confidentiality restrictions limited our neighborhood definition to be based on residential ZIP code, and these results may not hold for other neighborhood definitions, geographic settings or populations. In particular, the association of neighborhood poverty with less obesity may be specific to this low-income population. Finally, the pathways potentially linking neighborhood environments to adiposity were not separately identified in this study, and innovative research strategies are needed to support causal inference on the ways that neighborhood-level investments might affect child health.

Conclusions

Among preschool children from low-income NYC families, homicide rate was associated with a higher BMI z-score and a higher risk of obesity, and street trees were associated with a lower risk of obesity in some of our models. Examining the likely effectiveness of neighborhood improvement strategies to support health and reduce obesity in early life remains an important public health priority (Ogden et al., 2012Ogden et al., 2012; Van Cleave et al., 2010).

Acknowledgments

Abbreviations

BMI	body mass index (weight (kg)/height(m)^2)
NYC	New York City
GIS	Geographic Information Systems
GPS	Global Positioning Systems
PLUTO	Primary Land Use Tax Lot Output

References

Alfonzo MA. To Walk or Not to Walk? The Hierarchy of Walking Needs. Environment and Behavior. 2005; 37:808.

Almanza E, Jerrett M, Dunton G, Seto E, Pentz MA. A study of community design, greenness, and physical activity in children using satellite, GPS and accelerometer data. Health Place. 2012; 18:46–54. [PubMed: 22243906]

Bell JF, Wilson JS, Liu GC. Neighborhood greenness and 2-year changes in body mass index of children and youth. Am J Prev Med. 2008; 35:547–553. [PubMed: 19000844]

Beyea J, Hatch M. Geographic exposure modeling: a valuable extension of geographic information systems for use in environmental epidemiology. Environ Health Perspect. 1999; 107(Suppl 1):181–190. [PubMed: 10229717]

Blacksher E, Lovasi GS. Place-focused physical activity research, human agency, and social justice in public health: taking agency seriously in studies of the built environment. Health Place. 2012; 18:172–179. [PubMed: 21940195]

Boldemann C, Blennow M, Dal H, Martensson F, Raustorp A, Yuen K, Wester U. Impact of preschool environment upon children's physical activity and sun exposure. Prev Med. 2006; 42:301–308. [PubMed: 16448688]

Brown HS 3rd, Perez A, Mirchandani GG, Hoelscher DM, Kelder SH. Crime rates and sedentary behavior among 4th grade Texas school children. Int J Behav Nutr Phys Act. 2008; 5:28. [PubMed: 18479521]

Burdette HL, Whitaker RC. Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. Prev Med. 2004; 38:57–63. [PubMed: 14672642]

Burdette HL, Whitaker RC. A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children. Pediatrics. 2005; 116:657–662. [PubMed: 16140705]

Carver A, Timperio A, Hesketh K, Crawford D. Are children and adolescents less active if parents restrict their physical activity and active transport due to perceived risk? Social Science & Medicine. 2010; 70:1799–1805. [PubMed: 20347200]

Casagrande SS, Gittelsohn J, Zonderman AB, Evans MK, Gary-Webb TL. Association of Walkability With Obesity in Baltimore City, Maryland. Am J Public Health, AJPH. 2009:187492, v187491. In Press.

Cosco NG, Moore RC, Islam MZ. Behavior mapping: a method for linking preschool physical activity and outdoor design. Med Sci Sports Exerc. 2010; 42:513–519. [PubMed: 20068497]

Davison KK, Lawson CT. Do attributes in the physical environment influence children's physical activity? A review of the literature. Int J Behav Nutr Phys Act. 2006; 3:19. [PubMed: 16872543]

Durand CP, Dunton GF, Spruijt-Metz D, Pentz MA. Does community type moderate the relationship between parent perceptions of the neighborhood and physical activity in children? Am J Health Promot. 2012; 26:371–380. [PubMed: 22747320]

Evenson KR, Scott MM, Cohen DA, Voorhees CC. Girls' perception of neighborhood factors on physical activity, sedentary behavior, and BMI. Obesity (Silver Spring). 2007; 15:430–445. [PubMed: 17299117]

Ewing R, Cervero R. Travel and the built environment. Journal of the American Planning Association. 2010; 76

Freeman L, Neckerman K, Schwartz-Soicher O, Quinn J, Richards C, Bader MD, Lovasi G, Jack D, Weiss C, Konty K, Arno P, Viola D, Kerker B, Rundle AG. Neighborhood Walkability and Active Travel (Walking and Cycling) in New York City. J Urban Health. 2012

Gordon-Larsen P, Nelson MC, Page P, Popkin BM. Inequality in the built environment underlies key health disparities in physical activity and obesity. Pediatrics. 2006; 117:417–424. [PubMed: 16452361]

Grow HM, Saelens BE, Kerr J, Durant NH, Norman GJ, Sallis JF. Where are youth active? Roles of proximity, active transport, and built environment. Med Sci Sports Exerc. 2008; 40:2071–2079. [PubMed: 18981942]

Kerr J, Rosenberg D, Sallis JF, Saelens BE, Frank LD, Conway TL. Active commuting to school: Associations with environment and parental concerns. Med Sci Sports Exerc. 2006; 38:787–794. [PubMed: 16679998]

Larsen K, Gilliland J, Hess P, Tucker P, Irwin J, He M. The influence of the physical environment and sociodemographic characteristics on children's mode of travel to and from school. Am J Public Health. 2009; 99:520–526. [PubMed: 19106422]

Lee C, Moudon AV. Physical activity and environment research in the health field: implications for urban and transportation planning practice and research. Journal of Planning Literature. 2004; 19:147–181.

Lovasi GS, Bader MD, Quinn J, Neckerman K, Weiss C, Rundle A. Body mass index, safety hazards, and neighborhood attractiveness. Am J Prev Med. 2012a; 43:378–384. [PubMed: 22992355]

Lovasi GS, Grady S, Rundle A. Steps Forward: Review and Recommendations for Research on Walkability, Physical Activity and Cardiovascular Health. Public Health Reviews. 2012b; 33

Lovasi GS, Hutson MA, Guerra M, Neckerman KM. Built environments and obesity in disadvantaged populations. Epidemiol Rev. 2009a; 31:7–20. [PubMed: 19589839]

Lovasi GS, Jacobson JS, Quinn JW, Neckerman KM, Ashby-Thompson MN, Rundle A. Is the Environment Near Home and School Associated with Physical Activity and Adiposity of Urban Preschool Children? J Urban Health. 2011

Lovasi GS, Neckerman KM, Quinn JW, Weiss CC, Rundle A. Effect of individual or neighborhood disadvantage on the association between neighborhood walkability and body mass index. Am J Public Health. 2009b; 99:279–284. [PubMed: 19059849]

Lovasi GS, Schwartz-Soicher O, Neckerman KM, Konty K, Kerker B, Quinn J, Rundle A. Aesthetic amenities and safety hazards associated with walking and bicycling for transportation in New York City. Annals of Behavioral Medicine. In Press.

Lovasi GS, Underhill LJ, Jack D, Richards C, Weiss C, Rundle A. At Odds: Concerns Raised by Using Odds Ratios for Continuous or Common Dichotomous Outcomes in Research on Physical Activity and Obesity. Open Epidemiology Journal. 2012c; 5:13–17. [PubMed: 23002407]

Lumeng JC, Appugliese D, Cabral HJ, Bradley RH, Zuckerman B. Neighborhood safety and overweight status in children. Arch Pediatr Adolesc Med. 2006; 160:25–31. [PubMed: 16389207]

McDonald NC. Critical factors for active transportation to school among low-income and minority students. Evidence from the 2001 National Household Travel Survey. Am J Prev Med. 2008; 34:341–344. [PubMed: 18374248]

Neckerman KM, Lovasi GS, Davies S, Purciel M, Quinn J, Feder E, Raghunath N, Wasserman B, Rundle A. Disparities in urban neighborhood conditions: evidence from GIS measures and field observation in New York City. J Public Health Policy. 2009; 30(Suppl 1):S264–285. [PubMed: 19190579]

Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. JAMA. 2012; 307:483–490. [PubMed: 22253364]

Ogden CL, Kuczmarski RJ, Flegal KM, Mei Z, Guo S, Wei R, Grummer-Strawn LM, Curtin LR, Roche AF, Johnson CL. Centers for Disease Control and Prevention 2000 growth charts for the United States: improvements to the 1977 National Center for Health Statistics version. Pediatrics. 2002; 109:45–60. [PubMed: 11773541]

Oliver LN, Schuurman N, Hall AW. Comparing circular and network buffers to examine the influence of land use on walking for leisure and errands. Int J Health Geogr. 2007; 6:41. [PubMed: 17883870]

Papas MA, Alberg AJ, Ewing R, Helzlsouer KJ, Gary TL, Klassen AC. The built environment and obesity. Epidemiol Rev. 2007; 29:129–143. [PubMed: 17533172]

Rundle A, Goldstein IF, Mellins RB, Ashby-Thompson M, Hoepner L, Jacobson JS. Physical activity and asthma symptoms among New York City Head Start Children. J Asthma. 2009a; 46:803–809. [PubMed: 19863284]

Rundle A, Neckerman KM, Freeman L, Lovasi GS, Purciel M, Quinn J, Richards C, Sircar N, Weiss C. Neighborhood food environment and walkability predict obesity in New York City. Environ Health Perspect. 2009b; 117:442–447. [PubMed: 19337520]

Saelens BE, Handy SL. Built environment correlates of walking: a review. Med Sci Sports Exerc. 2008; 40:S550–566. [PubMed: 18562973]

Soobader MJ, LeClere FB. Aggregation and the measurement of income inequality: effects on morbidity. Soc Sci Med. 1999; 48:733–744. [PubMed: 10190636]

Spence JC, Cutumisu N, Edwards J, Evans J. Influence of neighbourhood design and access to facilities on overweight among preschool children. Int J Pediatr Obes. 2008; 3:109–116. [PubMed: 18465437]

Spruijt-Metz D. Etiology, Treatment and Prevention of Obesity in Childhood and Adolescence: A Decade in Review. J Res Adolesc. 2011; 21:129–152. [PubMed: 21625328]

Suglia SF, Duarte CS, Chambers EC, Boynton-Jarrett R. Cumulative social risk and obesity in early childhood. Pediatrics. 2012; 129:e1173–1179. [PubMed: 22508921]

Van Cleave J, Gortmaker SL, Perrin JM. Dynamics of obesity and chronic health conditions among children and youth. JAMA. 2010; 303:623–630. [PubMed: 20159870]

Weir LA, Etelson D, Brand DA. Parents' perceptions of neighborhood safety and children's physical activity. Prev Med. 2006; 43:212–217. [PubMed: 16712912]

Weiss CC, Purciel M, Bader M, Quinn JW, Lovasi G, Neckerman KM, Rundle AG. Reconsidering access: park facilities and neighborhood disamenities in New York City. J Urban Health. 2011; 88:297–310. [PubMed: 21360245]

Young CR, Peretz P, Jaslow R, Chamany S, Berger D, Brunetti J, Matte T, Van Wye G. Obesity in early childhood: more than 40% of Head Start children in NYC are overweight or obese. NYC Vital Signs. 2006; 5:1–2.

Zhu X, Lee C. Walkability and safety around elementary schools economic and ethnic disparities. Am J Prev Med. 2008; 34:282–290. [PubMed: 18374241]

Highlights

- Neighborhood homicide rate was associated with more obesity

- Street tree density was associated with less obesity

- Pedestrian-auto fatalities, parks, and walkability did not predict obesity

Table 1

Characteristics of children enrolled in a large means-tested preschool program in October 2004, New York City, NY

Individual Characteristics (N = 11,562)	Mean (SD) or %
Age (months)	44 (6)
Female	51%
Hispanic	57%
Black	26%
White/Asian	13%
Other	4%
BMI z-score	0.7 (1.3)
Normal weight	60%
Overweight	16%
Obese	24%

Table 2

Neighborhood characteristics estimated for 160 buffered residential ZIP code areas for 11,562 children enrolled in a large means-tested preschool program in October 2004, New York City, NY

	25th percentile	Median	75th percentile
Percent of residents below federal poverty line	12.2%	17.8%	27.3%
Percent of residents reporting race as black	4.5%	12.2%	35.8%
Percent of residents reporting foreign birth	24.4%	33.6%	45.0%
Walkability index[a]	−1.21	0.71	2.80
Percent of land area covered by small parks	0.8%	1.2%	2.1%
Percent of land area covered by large parks	1.2%	5.8%	13.3%
Street tree density (trees per km^2)	625	825	1,010
Homicide Rate (per 10,000 residents)	0.26	0.52	1.06
Pedestrian-auto fatalities (per 10,000 residents)	0.06	0.14	0.22

Note: The 25th, 50th, and 75th percentiles were calculated for the set of 160 ZIP code areas rather than at the individual level

[a]The walkability index was constructed by summing z-scores for residential density, land use mix, retail floor area ratio, intersection density, and subway stop density; higher values indicate more walkable urban form

Table 3

Neighborhood-level associations with BMI z-score from linear regression models in a population of 11,562 children enrolled in a large means-tested preschool program in October 2004, New York City, NY

Neighborhood characteristic	Full Sample N=11,562	Females N=5,857	Males N=5,705
	β [95% CI]	β [95% CI]	β [95% CI]
Percent poverty	**−0.10** [−0.16,−0.03]**	−0.08 [−0.16,0.00]	**−0.12* [−0.21,−0.02]**
Percent black	−0.05 [−0.11,−0.02]	−0.03 [−0.10,0.05]	−0.07 [−0.18,0.04]
Percent foreign-born	−0.01 [−0.07,0.06]	−0.04 [−0.09,0.02]	0.02 [−0.07,0.12]
Walkability Index	0.00 [−0.06,0.07]	−0.04 [−0.12,0.03]	0.05 [−0.05,0.15]
Percent area covered by small parks	−0.01 [−0.03,0.01]	−0.00 [−0.03,0.02]	−0.01 [−0.04,0.02]
Percent area covered by large parks	−0.006 [−0.05,0.03]	−0.04 [−0.09,0.01]	0.03 [−0.03,0.09]
Density of street trees	−0.02 [−0.08,0.03]	−0.03 [−0.10.0.03]	−0.01 [−0.09,0.07]
Homicide rate	**0.13*** [0.06,0.20]**	0.11 [−0.00,0.23]	**0.16*** [0.04,0.27]**
Pedestrian-auto fatalities	−0.01 [−0.06,0.03]	−0.00 [−0.05,0.05]	−0.02 [−0.09,0.04]

Notes: Values shown are from models adjusting for sex, race/ethnicity, age in months, and all neighborhood characteristics shown; neighborhood characteristics were measured for postal ZIP code plus a 400-m buffer surrounding the ZIP code, and these have been rescaled to have an interquartile range of 1

Table 4

Neighborhood-level associations with prevalence of obesity (vs. overweight or normal) from Poisson regression models in a population of 11,562 children enrolled in a large means-tested preschool program in October 2004, New York City, NY

Neighborhood characteristic	Full Sample N=11,562	Females N=5,857	Males N=5,705
	PR [95% CI]	PR [95% CI]	PR [95% CI]
Percent poverty	**0.87* [0.77,0.99]**	0.88 [0.71,1.08]	**0.86* [0.75,0.99]**
Percent black	0.96 [0.87,1.05]	0.94 [0.82,1.08]	0.97 [0.84,1.10]
Percent foreign-born	1.04 [0.94,1.16]	1.01 [0.88,1.15]	1.08 [0.94,1.23]
Walkability Index	1.01 [0.90,1.13]	0.99 [0.83,1.17]	1.03 [0.88,1.21]
Percent area covered by small parks	0.99 [0.94,1.04]	1.00 [0.93,1.07]	0.98 [0.93,1.03]
Percent area covered by large parks	0.97 [0.91,1.04]	0.90 [0.80,1.01]	1.05 [0.95,1.17]
Density of street trees	**0.88* [0.79,0.99]**	**0.85* [0.72,1.00]**	0.94 [0.80,1.09]
Homicide rate	**1.22** [1.05,1.41]**	1.21 [0.96,1.54]	**1.23** [1.06,1.44]**
Pedestrian-auto fatalities	1.01 [0.93,1.09]	1.01 [0.90,1.12]	1.02 [0.92,1.12]

Notes: Values shown are from models adjusting for sex, race/ethnicity, age in months, and all neighborhood characteristics shown; neighborhood characteristics have been rescaled to have an interquartile range of 1